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THE AREQUIPA OBSERVATIONS OF *MARS* AND *JUPITER.*

By Professor W. H. Pickering.

In the *Publications* A. S. P. for June, under the title "The Lowell Observatory in Arizona," Professor Holden criticises the observations made by myself and my assistant in Arequipa in 1892. My reply is based upon an examination of a proof-sheet which he has very kindly forwarded to me. As far as the criticism relates to the planet *Mars*, it appears to be at least in part a personal one. Personal controversies seem to me to be ill-suited to the pages of an astronomical magazine, but under the circumstances, I may perhaps be allowed a few words in reply, before dealing with other matters.

It is true that two years have already elapsed, and a full report of our observations has not as yet appeared. This is, I presume, also the case with the work of the Lick Observatory, since I have thus far seen only fragmentary articles by the various members of its corps of astronomers. I am in hopes that a full report upon our work, with illustrations, will appear in less than twelve months.

Fragmentary articles have also appeared, by the Arequipa observers, and it seems to me a little strange that Professor Holden should not have referred to them, instead of criticising the necessarily imperfect accounts of our work which were transmitted by cable. As is perfectly well known, a cable despatch consists merely of a disconnected series of words, the grammatical construction and finish being supplied by the newspaper staff. Some mistakes were almost necessarily made in deciphering the despatches, such as the one pertaining to "trouble in the Arean clouds," cited by Professor Holden, but as a whole I think that the *Herald* staff did their work remarkably well. Nevertheless, I do not expect to hold myself responsible for all the details of the wording of the telegrams, when precisely the same facts are stated in my own words in so well-known a periodical as *Astronomy and Astro-Physics* (Vol. XI, 1892, pages 668 and 849). The cablegrams were sent to inform other astronomers and the general public of the character of the work that we were doing, and to call the attention of the former to certain facts that we had observed, in the hope that they might confirm them while the planet was still near to us. A more detailed report was given later, as above noted, and a full report of all our observations will appear before long in a volume of the Annals of Harvard College Observatory.

As an instance of the injustice of basing a criticism of the Harvard work upon a mere cable despatch, let us take Professor HOLDEN'S first statement. He says: "'The *Herald* correspondent at Valparaiso cables as follows: 'Professor PICKERING of the Harvard Branch Observatory at Arequipa says that he discovered forty small lakes in *Mars*.' How does he know the dark markings are lakes? Why does he not simply call them dark spots? And is he sure there are forty?'" Now, if Professor HOLDEN had examined my article upon the subject in *Astronomy and Astro-Physics* for 1892, page 850, he would have read: "Scattered over the surface of the planet, chiefly on the side opposite to the two seas, we have found a large number of minute black points. * * * * Over forty of them have been discovered, and for convenience we have termed them lakes." We should have liked to have put all this into our cablegram, but instead we simply said "forty lakes." It does not seem to me that the word lake is objectionable. It has already been applied by SCHIAPARELLI to several of the larger dark areas upon the planet, *Solis Lacus*, *Lacus Phœnicis*, etc. The forty smaller bodies discovered in Arequipa differed apparently from those mentioned by SCHIAPARELLI, chiefly in size.

The same remarks apply to Professor HOLDEN'S criticism of the mountain chains. In the above-mentioned article, upon page 851 he will find the statement: "At present the snow is divided into two sections, one long and narrow, the other of irregular shape, and somewhat mottled. The appearance is such as might be produced by a mountain range and an area of irregular elevation, with a valley lying between them."

Regarding Professor HOLDEN'S criticism of our cloud observations, I may state that upon August 5 and 6, and also upon September 10, 12 and 13, small portions of the *limb* were seen to project beyond the general contour of the planet. As I understand it, the only previous similar observation was made at the LICK Observatory, and was due to the discovery of a visitor, who noticed a white point projecting beyond the *terminator*. (*Publications* A. S. P., Vol. VI, page 104.) Upon September 13, I recorded: "7^h 05^m Arequipa Mean time. Two distinct elevations not less than $0''.1$, nor more than $0''.2$. * * * Tried 700 diameters. Think projections do not exceed $0''.1$, but cannot be much less." Later Mr. DOUGLASS observed them, and at 10^h 15^m I write: "The northern projection is very conspicuous, and before Mr. DOUGLASS had told me what its peculiarity was, I thought I could possibly distinguish a dark line separating it from the planet. * * *" This dark line is well shown in a sketch made by Mr. DOUGLASS at 9^h 33^m.

Neither do I consider Professor HOLDEN'S effort to disparage the Harvard drawings, as compared to those made at the LICK Observatory, justifiable. I did not send finished india ink sketches to *Astronomy and Astro-Physics*, but merely line drawings, knowing that they could be published more cheaply, and yet would serve to illustrate my remarks. The Harvard drawings were not selected with a view of showing what fine detail we could see, but merely to show the changes exhibited by a certain region upon closely successive nights. The *Solis Lacus* region of *Mars*, sketches of which are exhibited by Professor HOLDEN, is the region showing perhaps the greatest amount of fine detail to be found anywhere upon the planet, and I think that our drawings of it indicate quite as many lakes and canals as do the drawings published by the LICK Observatory. In any case comparisons are odious, and I prefer to let our drawings, when published, speak for themselves, rather than to discuss the matter further at present.

Regarding the Arequipa observations of *Jupiter's* first satellite, the facts of especial note that we derived were two-fold:

(*a*) We stated that the satellite had the form of a prolate ellipsoid, or, popularly speaking, was egg-shaped.

(*b*) We stated that, unlike our Moon, it rotated upon its axis in a period different from that of its revolution around its primary.

Turning now to the *Publications* A. S. P., Vol. III, pages 355 and 359, we find that Professors SCHAEBERLE and CAMPBELL announce that Satellite I "is ellipsoidal, that its largest axis is directed toward the center of *Jupiter*." That is, they appear to agree with statement (*a*), but deny statement (*b*). These results are quoted from Professor HOLDEN'S paper in *Astronomy and Astro-Physics*, 1894, page 357.

On the other hand, in *Monthly Notices*, Vol. LIV, page 135, and again in *Astronomy and Astro-Physics*, 1894, page 274, Professor BARNARD, also observing with the 36-inch telescope, denies statement (*a*), but apparently confirms statement (*b*), for he says: "From peculiarities in the appearance of the belt, it is probable that the period of rotation on this axis is not coincident with the satellite's period of revolution about *Jupiter*."

Now, with such discordant statements emanating from three such eminent observers, all using the same telescope. I think many persons would be interested if Professor HOLDEN would state definitely what he considers to be the verdict of the great LICK telescope upon these two disputed points. As far as Mr. DOUGLASS and myself were concerned, using our Arequipa instrument, our results were always concordant upon these points, and appeared to each of us at the time unmistakable. Of course, we neither claim superior eyesight, nor an equal instrument. Can the difference be due to the atmosphere, which at Arequipa was almost always very steady? I can offer no other explanation of the circumstance, and merely state what appeared to us to be the facts.

But one point remains to which I wish to draw attention. Regarding the shadows of *Jupiter's* satellites, Professor HOLDEN says: "They are seen at certain times to be twice as long as they are broad, and this phenomenon is regularly observed here. I believe it was not noticed in Peru, which is strange, considering how much more difficult observations are reported." Why Professor HOLDEN should say that this phenomonon was not noticed in Peru, or where he got his information, I cannot conceive. I certainly do not remember ever writing anything which could convey such an impression. In point of fact, the appearance was so easy to perceive, and its explanation was so obvious, that we rarely even mentioned it in our records. In looking over my observations, however, I find a few notes upon the subject, among others, under date of November 18, 1892, the entry, "8^h 06^m.—A very elongated shadow has just appeared upon *Jupiter*." This proved to be the shadow of the second and smallest of the four original satellites. A later entry, under the same date, reads "8^h 30^m.—Shadow of the second is equatorially elongated, but not so much so as it appeared when first seen on the limb of the disc." This phenomenon was apparently first observed and explained by an amateur, Mr. BARNEBY, of England, who, on April 5, 1861, recorded the change of shape of the shadow of the third satellite, from an elongated streak to a circular spot. (*Chambers' Astronomy*, 4th ed., Vol. I, page 190.)

In making this reply to Professor HOLDEN'S criticism of my work, I have taken up in sequence all the points raised that seemed most important to me, and treated them as briefly as possible. I hope that no further discussion of the matter will be necessary. Professor HOLDEN, as he truly remarked, spoke courteously, but very plainly. I am glad that he did so, as it has given me an opportunity to endeavor to do the same. As I am sure he meant no personal offense in making his somewhat severe criticisms of the Harvard observations, so I in turn trust he will take none at my rejoinder.

ADDENDUM.—THE AREQUIPA OBSERVATIONS OF *MARS* AND *JUPITER* IN 1892.

By EDWARD S. HOLDEN.

I agree with Professor PICKERING that no further discussion of the Arequipa observations is now desirable, and the following paragraphs are only designed to make certain points quite clear before leaving them. I acknowledge the courteous tone of Professor PICKERING'S reply, and desire, as he does, to treat the matters in question entirely from a scientific standpoint.

Professor PICKERING entirely misses the important point of my paper. I criticised the large assertions of his cable-telegrams of 1892* (which were addressed to the newspaper readers of the whole world), because he announced various things, which were doubtful then and which he admits are not certain now, with a positiveness which was misleading and unwarranted.

He even went so far as to prophesy that certain melted snow would, by and by, flow in a particular direction. How could he possibly know which way was down-hill?

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* I quote part of a single one of these, as follows, and call attention to its very definite statements:

"*Mars* has two mountain ranges near the south pole. Melted snow has collected between them before flowing northward. In the equatorial mountain range snow fell on the two summits on August 5 and melted on August 7. These clouds (on *Mars*) are not white."